

Comments on a Review of the NuMI Horn System
August 10, 2001

Responses by Bruce Baller
May 6, 2004

Overview

Presenter: J. Hylen

1. (Reviewer: F. Lange) I know that this is not part of the review and the die has been cast, but I have always considered the sloped floor of the target hall to be detrimental to installing, servicing and repairing equipment.

This is unavoidable.

2. (Reviewer: M. Reichanadter) Although not part of this review, I wanted to comment that it is important to have a well designed RAW system for the primary cooling of the horn, which must be carefully integrated into the regular maintenance and replacement of the horn systems to ensure the safe operation of the NuMI experiment.

Done.

3. (Reviewer: M. Reichanadter) Another comment not related to the review materials but I feel is important in the operation of a high radiation targeting and collection facility, is the need for remotely inspecting of activated components. Does NuMI have lead glass windows or remote cameras to allow for remotely viewing horns or targets that have been activated?

Yes.

4. (Reviewer: R. Stanek) With respect to horn alignment, is it clear that if all the possible sources of misalignment (manufacturing, mounting, vibration, thermal, etc,) add up, that you are still within budget?

Yes. The alignment budget is based on a higher energy neutrino beam which is more severe than the planned operation with a low energy beam.

Horn Design Features

Presenter: K. Anderson

1. (Reviewer: M. May) Prototype testing needs to be started as soon as possible on all items that are going into the target hall. Things such as the binding of the long threaded rods through the shield blocks need to be tested. The multi clamp joint joining the stip line to the horn could have many unforeseen problems, therefore

the design needs to be completed as soon as possible and a prototype built and fully tested.

Done.

2. (Reviewer: M. May) Corrosion of all hardware and mechanical parts that have motion need special attention. Back up plans should be made for all key items in the case that they fail due to corrosion or binding.

Done.

3. (Reviewer: M. May) Rust contamination should be looked at and the right type of protective coatings should be applied to all materials that have a tendency to corrode.

Done.

4. (Reviewer: M. Reichenadter) A minor concern on the horn #1 alternating stresses predicted by the FEA (+2/-2.5mil displacements). Kris had explained that the pre-load had been optimized across the horn and that some areas (endcap?) would experience alternating tensile and compressive stresses. If not already employed, please consider etching and polishing the aluminum components to reduce microscopic irregularities that could lead to crack initiation during cyclic loading.

Done.

5. (Reviewer: R. Stanek) For all of the connections (water and mechanical) is there a specification for the number of make & breaks that will occur? If so, does the "test cycle" exceed this by a fair margin of safety?

The number of re-connections should be very small (~1/several years), otherwise there are more severe design flaws that necessitate frequent horn replacement.

6. (Reviewer: R. Stanek) What is the manufacturing plan for the horns? Will all horns be machined and welded at one time or will you machine all, but only weld the first two (waiting to see what problems might occur)?

The horns were made sequentially.

7. (Reviewer: R. Stanek) How will you tell when a nozzle might get plugged and what would you do if this happened? (It may be that nozzle plugging can be totally eliminated with proper filtering)

It is possible that a single plugged nozzle could be detected by flow/pressure measurements. There is no simple scheme for un-plugging a nozzle however. We would likely run until the horn failed.

Vibration Study

Presenter: F. Nezrick

1. (Reviewer: M. Reichenadter) Frank Nezrick's vibration analysis was very thorough and showed no concerns of excessive stresses from reflected waves, resonance modes, or other vibrational sources.

OK

2. (Reviewer: D. Snee) The horn vibration may be greater with ever thing hanging from the top not of the floor as in test stand also the water return tank hanging of the horn and not the module with all its adjustments.

The module is a massive structure compared to the horn. The vibration modes are unlikely to change with the method of support.

3. (Reviewer: R. Stanek) The use of the prototype seems to have been a tremendous help in terms of confirming the design and manufacturing technique for the horns. I encourage testing to continue with specific emphasis on testing vibration and alignment under as close to final conditions (mounting support, temperature, water flow rate) as possible.

OK

Support Module

Presenter: R. Silva

1. (Reviewer: M. Reichenadter) On the horn positioning module. It was stated that the design incorporates features that facilitate the handling and replacing defective or failed components. It is not clear that this is the case for the lower end of the positioning module that incorporates a number of small tolerance moving parts (bearings, slides, eccentrics, etc.). The NuMI team should expect that, while excellent material choices have been made with respect to the high radiation environment, the positioning module may lose its ability to position the horn remotely over time. The lithium lens module, with an order of magnitude less activation, seized up in a few years operation, and was not longer able to make fine adjustments of the lens. Suspected failure modes were radiation swelling of materials, or perhaps rust particles that bind in the clearances. NuMI may wish to consider building a spare module, or incorporating remote adjustment features

into the entire module, or some other method to allow horn positioning in the event the module adjustment mechanisms fail.

We do not anticipate re-positioning the horns after the alignment has been confirmed during commissioning. The motion controls will be exercised in the work cell when a horn is swapped out. Some minimal repairs may be possible. Care has been taken in the selection of materials for this application using experience gained in pbar.

2. (Reviewer: M. Reichanadter) Be sure that the four lifting points are designed conservatively by analyzing a two point lift scenario.

OK

3. (Reviewer: R. Stanek) I assume that the Support Module will have a formal Engineering Note and be load tested (just like a Below the Hook Lifting Device).

Yes

4. (Reviewer: R. Stanek) It appeared that the exact details of the drip tray are still being worked out. Are all connections would be covered by the tray?

No. Any drips from water connections will fall into the chase. The water will be evaporated and exhausted.

5. (Reviewer: R. Stanek) Will a motor failure produce any special issues (radiation, alignment)? What happens to alignment when a replacement is made?

See response above regarding motion controls.

Remote Clamp

Presenter: K. Anderson

1. (Reviewer: P. Martin) The test plan for the prototype remote clamp needs to be developed.

The remote clamp was tested at MI8.

2. (Reviewer: D. Snee) Concerned on the remote stripline clamp parts all stay in together when assembling and disassembling. Prototype should be made.

The stripline clamp was assembled and disassembled with no problems.

3. (Reviewer: R. Stanek) The remote clamp is still under design. I support the plan to prototype and test this component along with any other remote connections.

OK